Health impacts of city policies to reduce climate change in 2 Chinese and 5 European cities: a comparison of differing health impacts and mitigation priorities through transport, building and energy policy scenarios

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Sharing international experience on urban planning for promoting health and environmental sustainability Workshop,
LSHTM Jun 2016

Project Aim

FP7 Project: 2011-2015
€ 3.5 Million
17 Partners, in Europe and China. University of Bristol is the PI.

Aim:

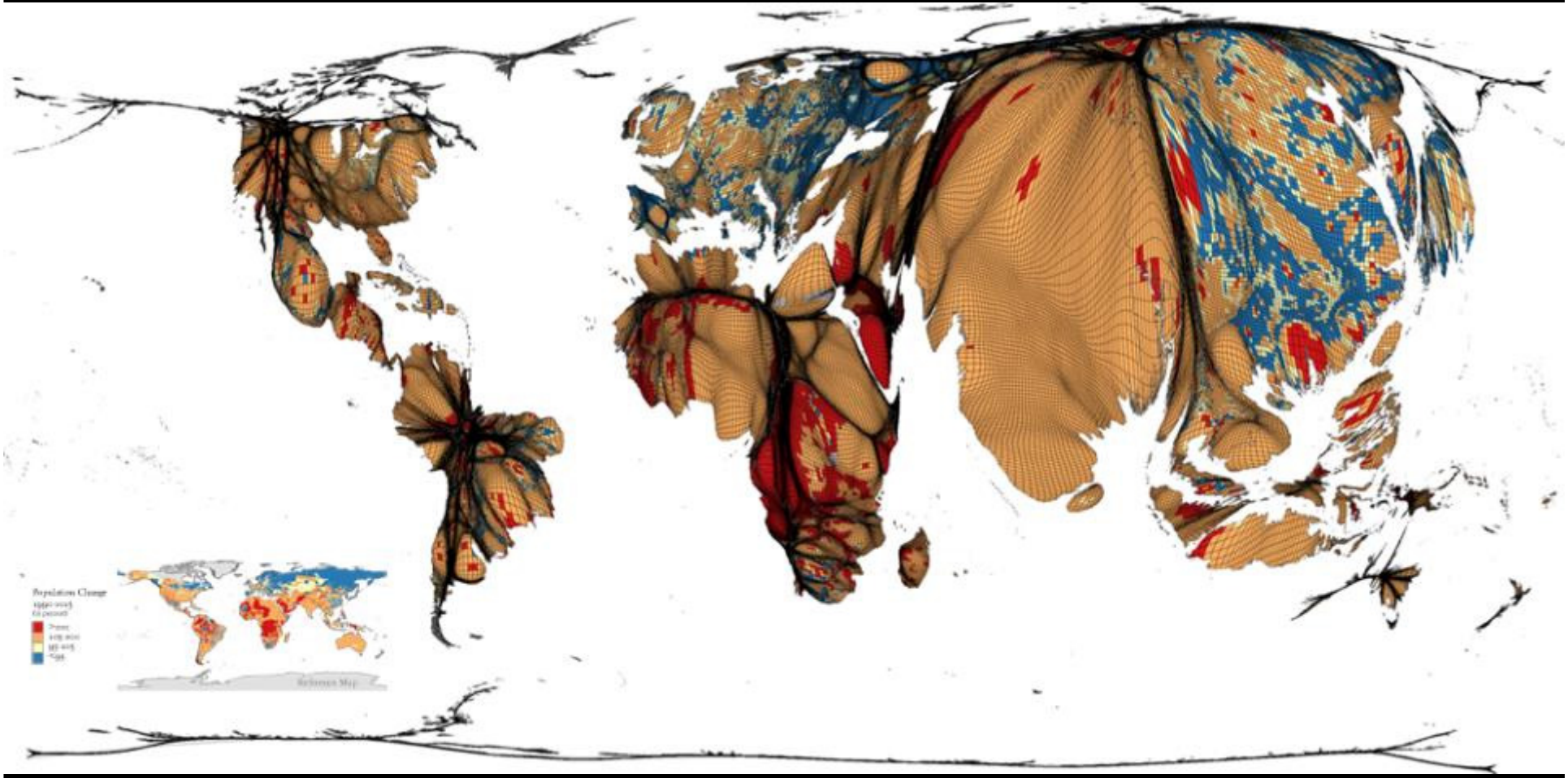
- To examine real city policies and future scenarios to investigate the health impact of these climate-change reduction policies.

- Working with 5 cities in Europe, 2 in China. Paired arrangement between each city and a local university.

- Investigating 3 policy areas – transport, housing and energy.

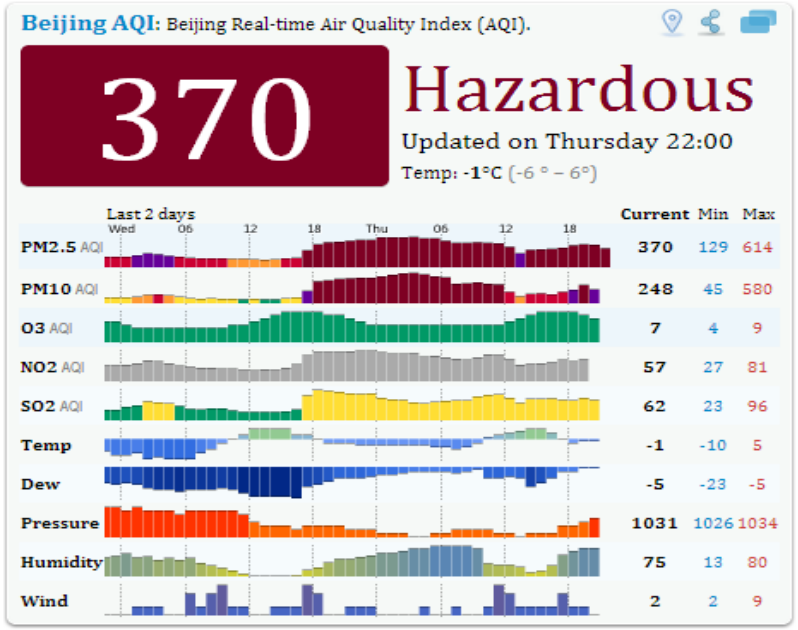
- www.urgenche.eu
  - See policy Briefings
    - Traffic; buildings; energy; wellbeing

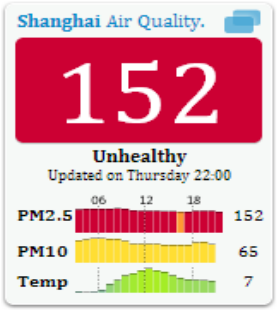
Population change 1990-2015

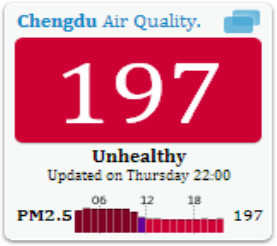


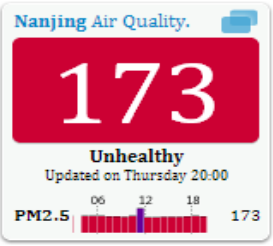
Beijing Air Pollution: Real-time Air Quality Index (AQI)

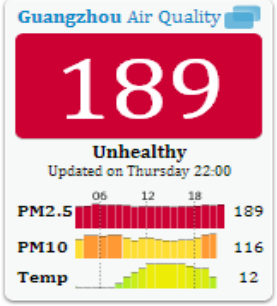
BEIJING 北京 | SHANGHAI 上海 | GUANGZHOU 广州 | CHENGDU 成都 | HONGKONG 香港 | NANJING 南京 | SHENZHEN 深圳 | MORE CITIES







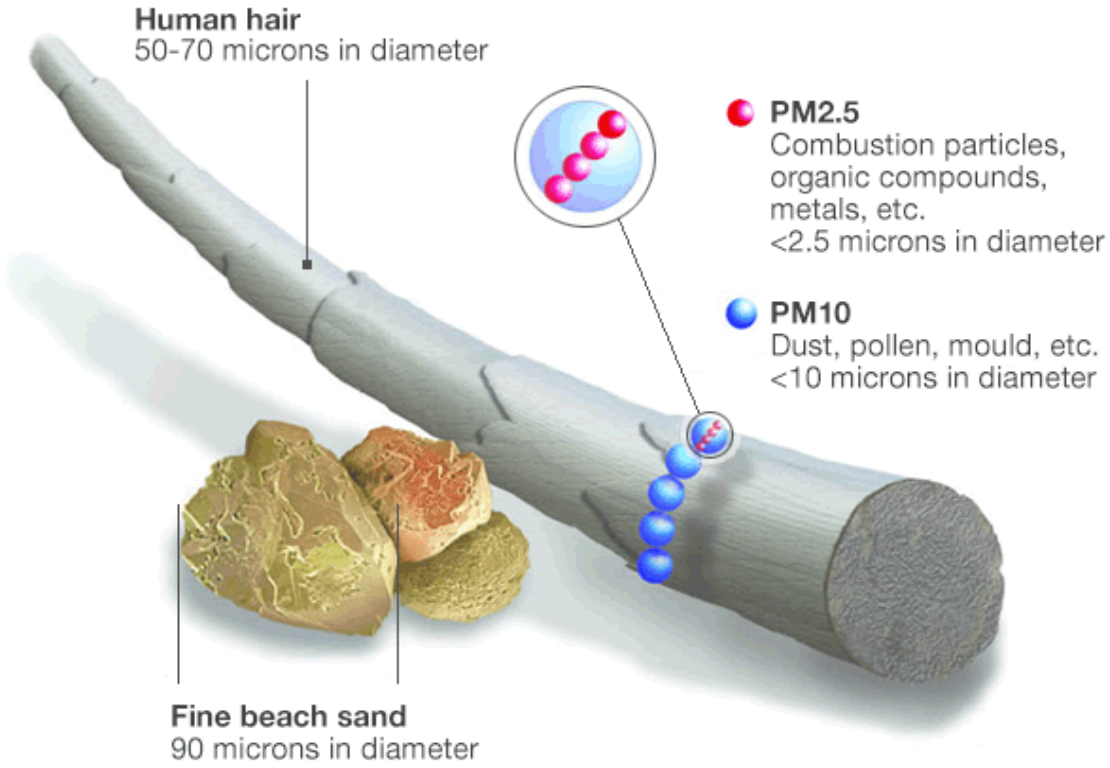




Mon 19/1 2015

AQI	Air Pollution Level	Health Implications
0 - 50	Good	Air quality is considered satisfactory, and air pollution poses little or no risk
51 -100	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
101-150	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
151-200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects
201-300	Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.
300+	Hazardous	Health alert: everyone may experience more serious health effects

PM – health risks



Source: US EPA

- World Health Organization (WHO) sets a maximum safe limit of exposure over a 24-hour period: 25 $PM_{2.5}$ particles in every cubic metre of air.
- $PM_{2.5}$ - Fragments of unburned fuel that are small enough to reach the lungs and, in the smallest cases, to cross into the bloodstream

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The New York Times

Asia Pacific

Air Pollution Linked to 1.2 Million Premature Deaths in China

Aly Song/Reuters

Shanghai in January. Researchers said the toll from China's pollution meant the loss of 25 million healthy years in 2010.

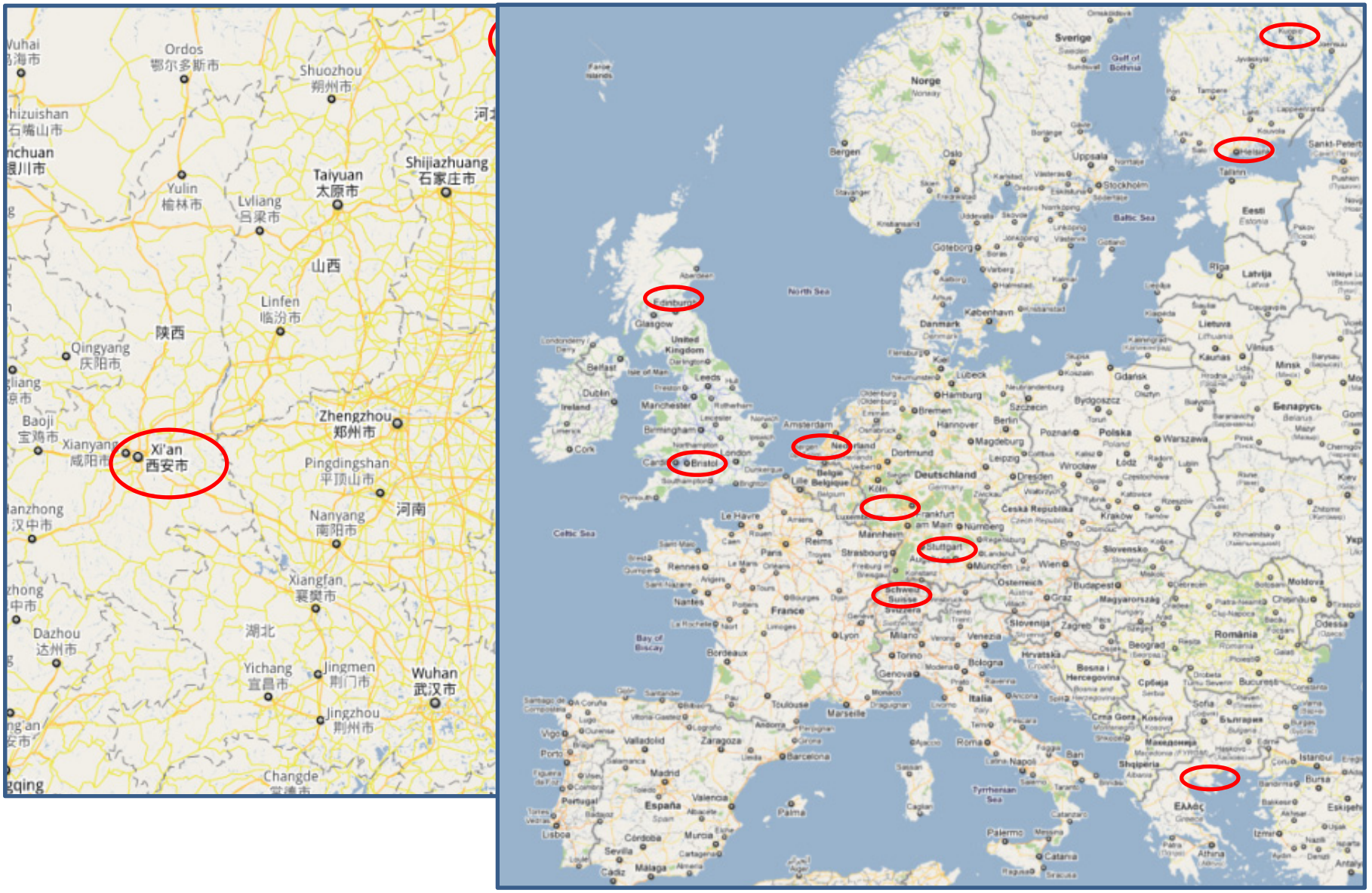
By EDWARD WONG
Published: April 1, 2013 | 40 Comments

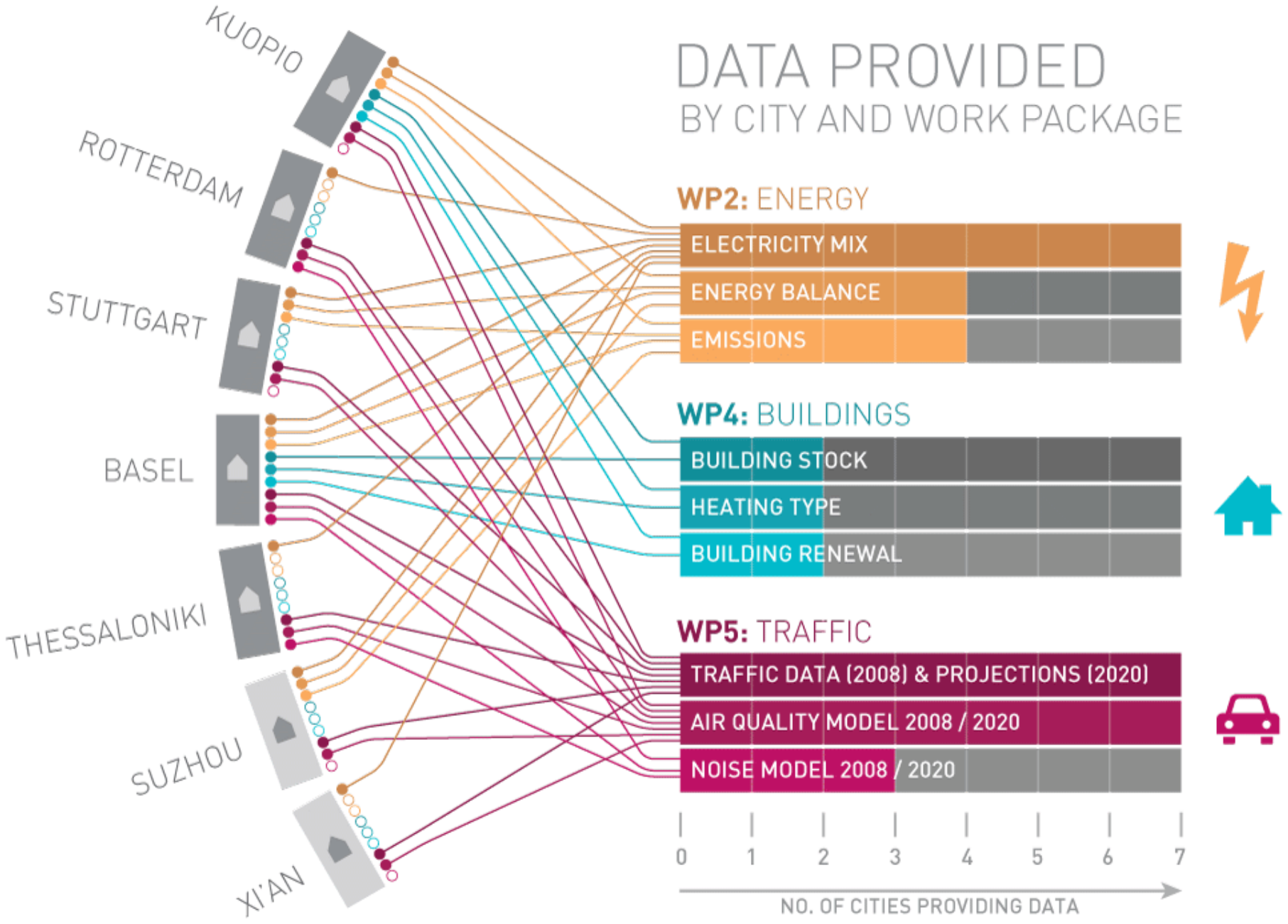
BEIJING — Outdoor air pollution contributed to 1.2 million premature deaths in China in 2010, nearly 40 percent of the global total, according to a new summary of data from a scientific study on leading causes of death worldwide.

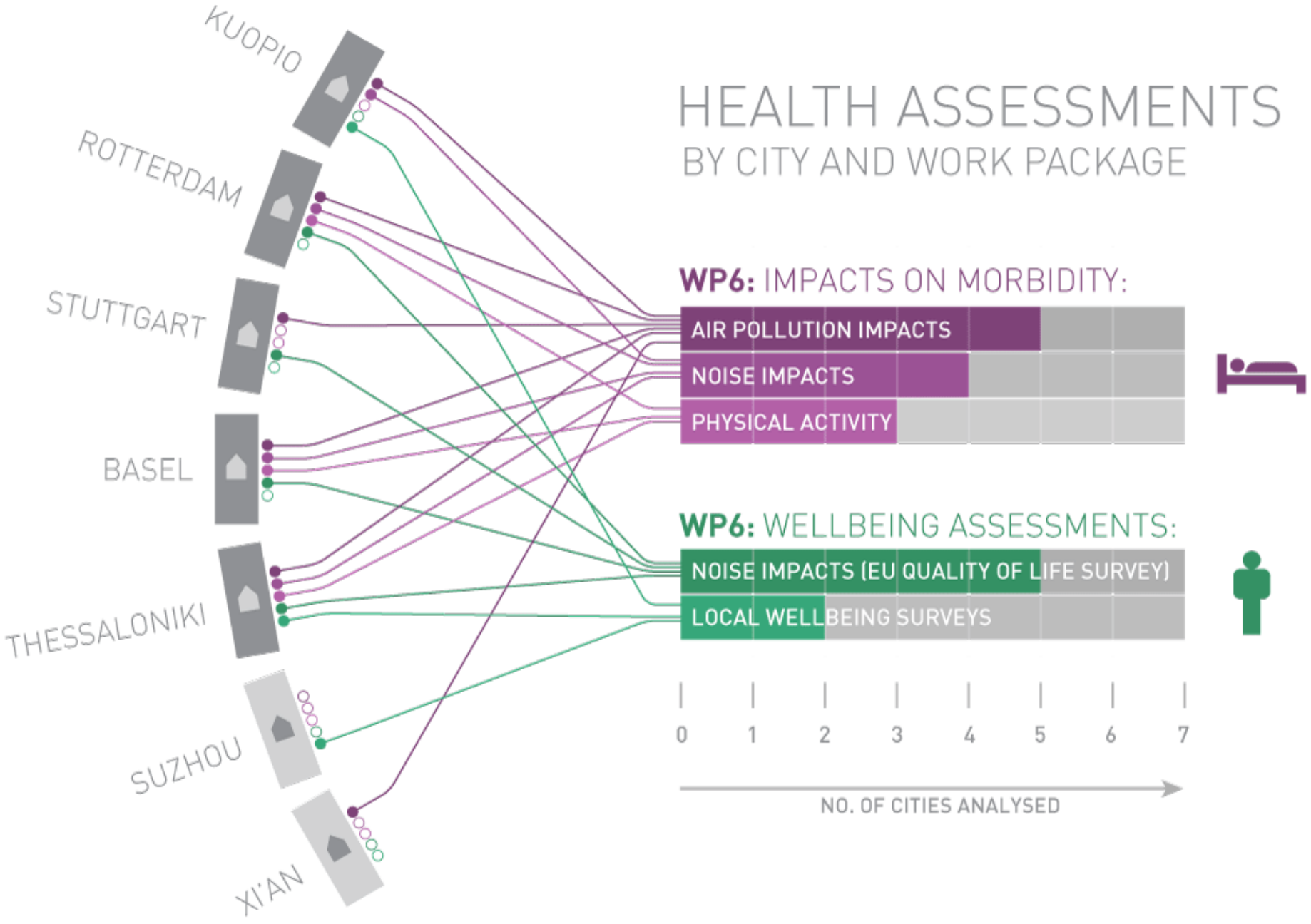
The Partnership

Participant no. *	Participant organisation name	Participant abbreviation	Country
1 coordinator	University of Exeter	UExeter	United Kingdom
2	City of Suzhou	CSuzhou	China
3	City of Xi'an	CXi'an	China
4	City of Basel	CBasle	Switzerland
5	City of Kuopio	CKuopio	Finland
6	City of Rotterdam	CRott	The Netherlands
7	City of Stuttgart	CStutt	Germany
8	Peking University	UPek	China
9	Nanjing University	UNanj	China
10	Centre for Research and Technology Hellas	CERTH	Greece
11	Institute of Occupational Medicine	IOM	United Kingdom
12	Suomen Ymparistokeskus	SYKE	Finland
13	Terveyden ja Hyvinvoinnin Laitos	THL	Finland
14	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk	TNO	The Netherlands
15	Universitaet Stuttgart	UStutt	Germany
16	Swiss Tropical Institute	STI	Switzerland
17	World Health Organization Regional Office for Europe	WHO	Denmark/Germany/Italy

Project Team




KUOPIO
ROTTERDAM
STUTTGART
BASEL
THESSALONIKI
SUZHOU
XI'AN
DATA PROVIDED
BY CITY AND WORK PACKAGE
WP2: ENERGY
ELECTRICITY MIX
ENERGY BALANCE
EMISSIONS
WP4: BUILDINGS
BUILDING STOCK
HEATING TYPE
BUILDING RENEWAL
WP5: TRAFFIC
TRAFFIC DATA (2008) & PROJECTIONS (2020)
AIR QUALITY MODEL 2008 / 2020
NOISE MODEL 2008 / 2020
0 1 2 3 4 5 6 7
NO. OF CITIES PROVIDING DATA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STUTTGART
BASEL
THESSALONIKI
SUZHOU
XI'AN
HEALTH ASSESSMENTS
BY CITY AND WORK PACKAGE
WP6: IMPACTS ON MORBIDITY:
AIR POLLUTION IMPACTS
NOISE IMPACTS
PHYSICAL ACTIVITY
WP6: WELLBEING ASSESSMENTS:
NOISE IMPACTS (EU QUALITY OF LIFE SURVEY)
LOCAL WELLBEING SURVEYS
0 1 2 3 4 5 6 7
NO. OF CITIES ANALYSED

Rotterdam, Netherlands
"Europe's largest port"

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🛠 Freight transport, petro chemistry and a large port-industrial area
: Gas, oil, wind, some solar, building coal plant
Climate change threats identified:
Flooding, heat island
GHG reduction policies*:
Increasing vegetation, high density housing
Electric cars, fewer vehicles, biofuels, improved cycle network
Reuse of waste heat from industry, carbon capture & storage

Stuttgart, Germany
"big city with a small town atmosphere"

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🛠 Research & development (car companies headquarters)
gas, oil, coal, waste, renewable (solar)
Climate change threats identified:
Poor air quality, heat stress
GHG reduction policies:
Congestion charge, parking restrictions, improved light rail service, improved cycling network
Restrictions on use of domestic pellet boilers

Kuopio, Finland
"lakeside town"

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€€€€€€€€€€ €€€€€€€€€€ €€€€€€€
🛠 small and medium sized businesses and public and private services
peat, oil, wood
Climate change threats identified:
loss of snow cover, eutrophication of lakes, mould growth in houses
GHG reduction policies:
Energy efficiency in new & existing homes
Biofuels
Change from peat to wood

Basel, Switzerland
"cosmopolitan city in your pocket"

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🛠 banking, pharmaceuticals, chemicals, machinery, printed materials,
Hydroelectric & wind
Climate change threats identified:
Flooding from Rhine, glaciers melting reducing water supply for hydroelectric
GHG reduction policies:
Insulation
Electric cars, fewer vehicles, active transport (road in tunnel)
Increased use of solar

Urgenche Climate-Change City Policies

Key:
🧍 Population (100 000s)
€ Euros per capita (1000s)
🛠 Industries
Energy supply & energy policies
Buildings policies
Transport policies

Suzhou, China
"garden-style city"

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🛠 ICT, chemical, textiles & clothing, electronic, machinery & mechanical parts
coal, gas
Climate change threats identified:
>4% decline in industry and enterprises by 2050
GHG reduction policies:
Energy efficiency in new & existing homes
Electric cars, fewer vehicles,
Shut polluting industries, reduce emissions from industry increased use of gas and solar

Thessalonik,i Greece
"Greece's second major city"

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🛠 Port, machinery, textiles, steel, oil, cement, flour, petrochemical, liquor, services
Lignite, gas
Climate change threats identified:
Heat stress, forest fires
GHG reduction policies:
Insulation
new metro, electric cars

Xian, China
"regional industrial centre"

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€€€€
🛠 high tech (ICT, automotive, aerospace) , tourism
nuclear, hydroelectric, gas, coal, biomass
Climate change threats identified:
Water shortages
GHG reduction policies:
Electric cars, fewer vehicles, new metro
move to renewable energy

City of Thessaloniki case-study
Transport Policies considered

Scenario	Economic Drive	Policies Considered			
	Gross domestic product	METRO Construction	Usage of Electric Cars	Technologies Penetration in Passenger Cars,	
2010 Baseline	GDP 2010(*)	NO	NO	(**)	Gasoline passenger cars: 97.6% Diesel cars: 1.4% Hybrid Cars: 1%
2020 BAU	GDP 2020(*)	NO	NO	(**)	Gasoline passenger cars: 91% Diesel cars: 1% Hybrid Cars: 8%
2020 CO2	GDP 2020(*)	**YES**	**YES**	(***)	Gasoline passenger cars: 68% Diesel cars: 22% Hybrid Cars: 8% Electric Cars: 2%

(*): GDP analysis, Eurobank Research

(**): Data from SIBYL Model, http://www.emisia.com/sibyl/

(***): Expert Elicitation

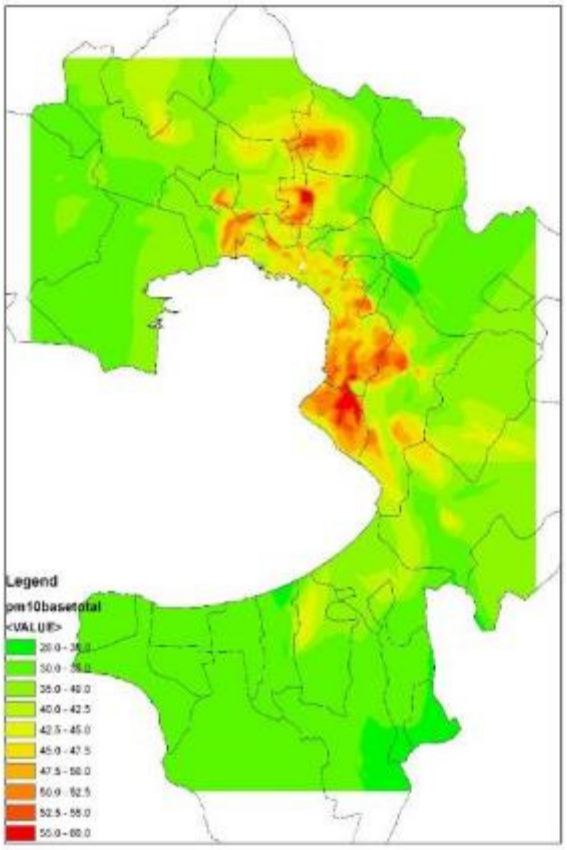
Data Used

- **Building Footprint and Building Height**
- **Thessaloniki GIS Road Geometry**
- **Hourly Variation in traffic flow and velocity**
- **Hourly variation in traffic composition per vehicle class**
- **Population Data per building block**

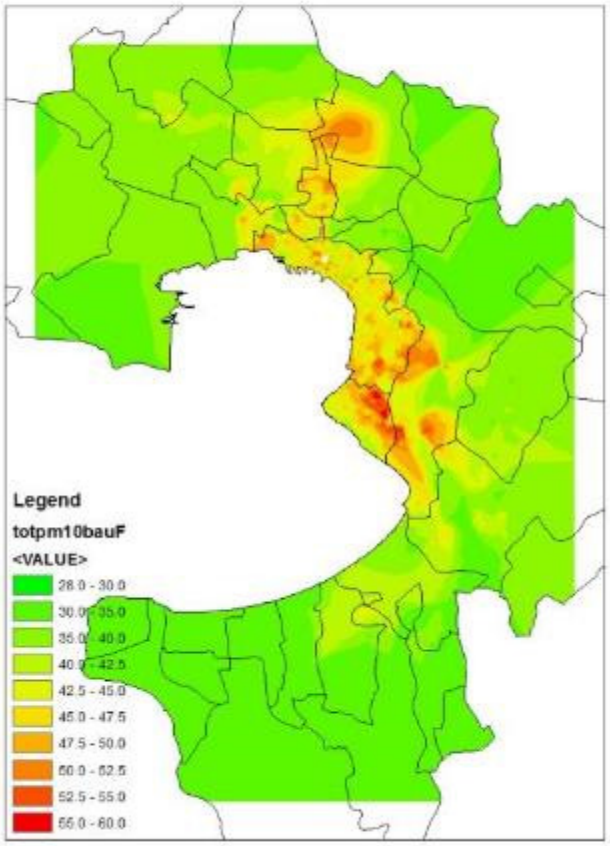
- **Metereological and Pollution Data** (Mikra, Kalamaria, AUTH, Panorama, Sindos, Kordelio, Neoxorouda Stations)
- **Urban Background Pollution** (Eptapyrgio and Neoxorouda Station)

PM_{10} Scenarios

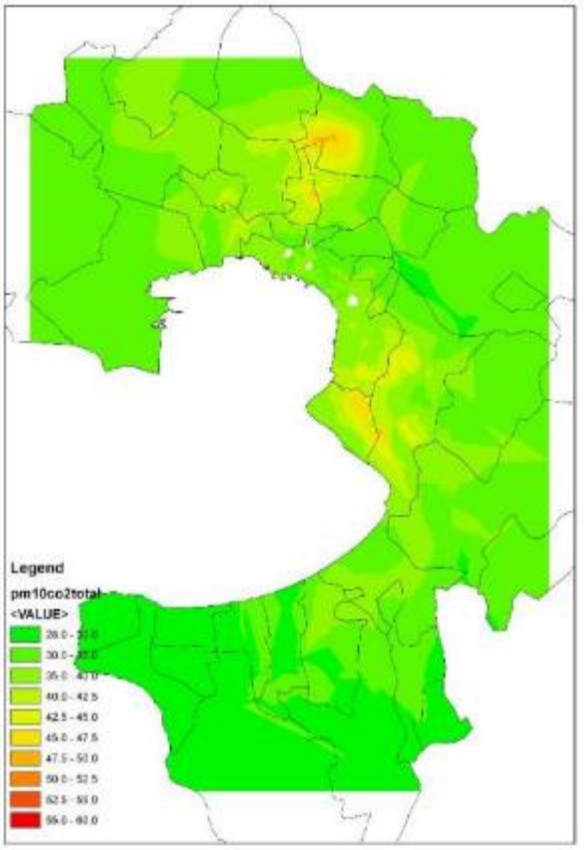
Baseline 2010



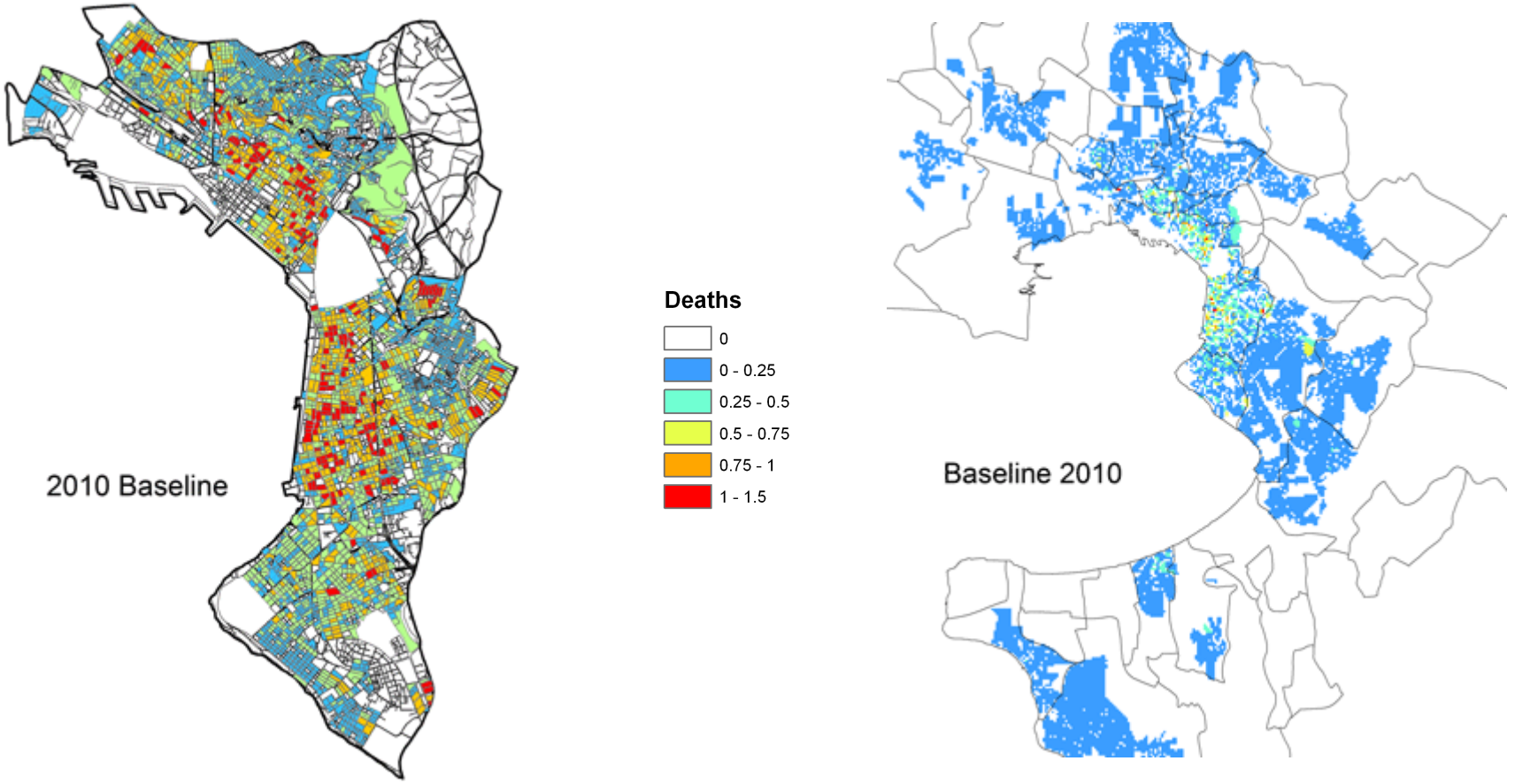
BAU 2020



CO2 2020



Annual number of deaths attributed to PM_{10}



(animated)

Health Impact in the city

Annual number of deaths attributed to PM_{10} and NO_2 and leukemia lifetime expected cases due to Benzene

Municipality	PM10			NO2			Benzene		
	2010	BAU	CO_2	2010	BAU	CO_2	2010	BAU	CO_2
Thessaloniki	404.1	418.6	348.6	104.1	124.1	97.7	8.9	8.3	4.0
Sykeai	40.4	40.8	34.7	10.4	12.7	10.4	0.9	0.9	0.5
Agiou Paylou	8.6	8.8	7.3	2.3	2.9	2.3	0.2	0.2	0.1
Eukarpia	6.6	7.1	6.6	1.4	1.5	1.2	0.0	0.0	0.0
Ambelokipi	44.6	48.1	39.0	10.9	13.3	10.5	1.0	0.9	0.5
Kalamaria	108.0	108.2	94.6	26.5	31.2	25.2	2.1	2.0	1.0

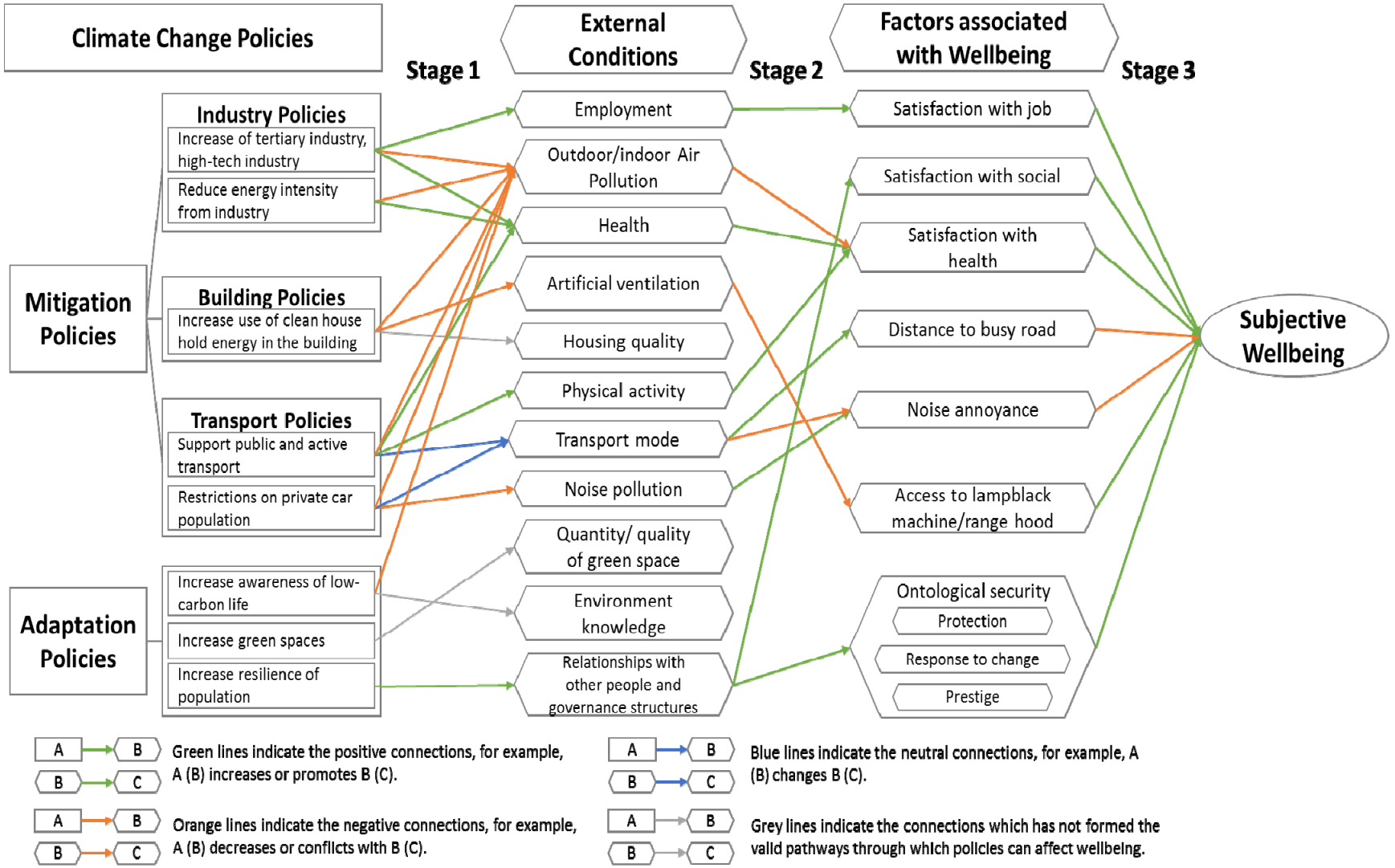
Wellbeing Methodology

- 775 **Questionnaires** administered in Aug 2013
- **Wellbeing measure** – WHO-5 Wellbeing scale
  - "I have felt cheerful and in good spirits",
  - "I have felt calm and relaxed"
  - "I have felt active and vigorous"
  - "I woke up feeling fresh and rested", and
  - "My daily life has been filled with things that interest me"
- **Statistical analysis -** Generalized estimation equation modelling to reveal external conditions associated with wellbeing

Climate Change Mitigation and Adaption Policies examined in Suzhou

Policy Category	Specific Measures	External Conditions Affected
Mitigation policy	Increase of tertiary industry, high-tech industry	Employment rate, quality and salary [27]
		Air quality and related health [2,28]
	Reduce energy intensity from industry	Air quality and related health [2,28]
	Increase use of clean household energy in the building	Indoor air quality [29]
		The use of artificial ventilation system like the air conditioner and kitchen range hoods [30]
		Housing quality [31]
	Support public and active transport	Transport mode [32]
		Air quality [33,34]
		Physical activity and health [35–37]
	Restrict private car population	Transport mode [26,32]
		Air quality [33,34]
		Noise pollution [33,34]
	Increase awareness of low-carbon life	Air quality [33,34]
		Environmental opinions [38]
Adaptation policy	Increase green spaces	Quantity/quality of green space [39]
	Increase resilience of population	Relationships with other people and governance structures [40]

Climate Change Wellbeing Pathways



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Lessons learned from Chinese and EU case studies

China

Data access limited

- Few GIS files: road structure and buildings: hence no noise modelling
- No traffic data (current) and scenario (future)
- No primary health data available

(resolved via “open source”)

AQ monitoring: regional/high-rise buildings

- AQ at urban/regional background (14 m height) and not at ground level (traffic)

Collaboration

- Limited interaction with city partners on results – Need top-down buy-in from City Mayor

EU

Data access complex

- Much specific local data but difficult to apply in general method
- Political sensitive to analyse other scenarios

(close collaboration with city-partner)

AQ monitoring: local/exposure

- AQ at urban, regional and traffic locations at ground level

Collaboration

- More interaction with city-partners on results but results politically difficult in some instances

Conclusions: Europe and China

- Different scale of problems

  (size of cities and metropolitan areas, growth rates)

- Different levels of exposure

  (China 10x air pollution exposure)

- Different Political systems, different drivers
  - Economic growth v Sustainable liveable cities
  - In hindsight, in China, needed top down connections (City Mayor)

Selected Project Papers

Sabel C E, Hiscock R, Asikainen A, Bi, J, Depledge M, van den Elshout S, Freiedrich R, Huang, G, Hurley F, Jantunen M, Karakitsios S P, Keuken M, Kingkham, S, Kontoroupis P, Kuenzli N, Liu M, Martuzzi M, Morton K, Mudu P, Niittynen M, Perez L, Sarigiannis D, Stahl-Timmins W, Tobollik M, Tuomisto J and Willers S (2016) **Public Health impacts of city policies to reduce climate change: findings from the URGENCHE EU-China project**, Environmental Health, 15 (Suppl 1):25.

Thomas, F, **Sabel C E**, Morton K, Hiscock, R, Depledge M (2014) **Extended impacts of climate change on health and wellbeing**, Environmental Science and Policy, 44, 271-278.

Keuken, M, Jonkers, S, Verhagen, H, Perez, L, Trueb, S, Okkerse, W-J, Liu, J, Pan, X, Zheng, L, Wang, H, Xu, R & **Sabel C E** (2014) **Impact on air quality of measures to reduce CO2 emissions from road traffic in Basel, Rotterdam, Xi'an and Suzhou**, Atmospheric Environment, 98, 434-441.

Hiscock R, Mudu P, Braubach M, Martuzzi M, Perez L, **Sabel C E** (2014) **Wellbeing Impacts of City Policies for Reducing Greenhouse Gas Emissions,** International journal of environmental research and public health, 11 (12), p. 12312-12345.

Willers S M, Marcel Jonker, Lisette Klok, Menno P. Keuken, Jennie Odink, Sef van den Elshout, **Sabel C E,** Johan P. Mackenbach, Alex Burdorf (2016) **High resolution exposure modelling of heat and air pollution and the impact on mortality**, Environment International, 89-90, 102-109.

Perez L., Trüeb S., Cowie H., Keuken M.P., Mudu P., Ragettli MS., Sarigiannis D.A., Tobollik M., Tuomisto J., Vienneau D., **Sabel C. E.**, Künzli N (2015) **Transport-related measures to mitigate climate change in Basel, Switzerland: a health effectiveness comparison study**, Environment International, 85, 111-119.

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谢谢 Thank you